APPENDIX A. T 117 PROPOSED REMOVAL BOUNDARY TECHNICAL MEMORANDUM

Lower Duwamish Waterway Superfund Site

Terminal 117 Early Action Area

EE/CA APPENDIX A:
T-117 PROPOSED REMOVAL BOUNDARY TECHNICAL MEMORANDUM

For submittal to:

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Table of Contents

Acronyms

Acronym	definition
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act (Superfund)
City	City of Seattle
CSL	cleanup screening level
EAA	early action area
Ecology	Washington State Department of Ecology
EE/CA	engineering evaluation/cost analysis
EPA	US Environmental Protection Agency
LDW	Lower Duwamish Waterway
LDWG	Lower Duwamish Waterway Group
MLLW	mean lower low water
OC	organic carbon normalized
PCB	polychlorinated biphenyl
Port	Port of Seattle
RI/FS	remedial investigation/feasibility study
SMS	Washington State Sediment Management Standards
SQS	Sediment Quality Standard
T-117	Terminal 117

1.0 Introduction

The Terminal 117 (T-117) site has been identified as an early action area (EAA) of the Lower Duwamish Waterway (LDW) Superfund site. The LDW site was added to the US Environmental Protection Agency's (EPA's) National Priorities List (the national list of sites for the Comprehensive Environmental Response, Compensation, and Liability Act, or CERCLA, also known as Superfund) on September 13, 2001. The Phase 1 remedial investigation (RI) for the LDW (Windward 2003a) was a summary of current LDW conditions based on previous studies. One of the primary objectives of the Phase 1 RI was to identify areas within the LDW site that might be candidates for early cleanup action because of their potential for higher levels of risks. Windward (2003b) prepared a technical memorandum that recommended seven areas to EPA and the Washington State Department of Ecology (Ecology) for early remediation action. The T-117 EAA, located at approximately river mile 3.6 on the west side of the waterway, was one of the seven recommended areas. EPA determined that two of these areas (Slip 4 and T-117) would be investigated and cleaned up as Superfund non-time-critical removals.

Investigation of the T-117 EAA is being conducted under the existing Administrative Order on Consent (Cohen 2003) agreed to by the key parties involved in the RI and feasibility study (FS). The key parties include the City of Seattle (City), King County, the Port of Seattle (Port), and The Boeing Company—working together in the LDW as the Lower Duwamish Waterway Group (LDWG)—plus EPA and Ecology. Although all four members of LDWG are responsible for the LDW Superfund Site RI/FS documents, work at the T-117 EAA is being performed by the Port and the City.

A work plan (Windward et al. 2003b)was written to describe the technical approach for the following four tasks at T-117:

- Summary of existing information and data gaps analysis report and quality assurance project plan (Task 1)
- Cruise and data report (Task 2)
- Technical memorandum on boundaries of the removal action (Task 3)
- Community involvement (Task 10)

This technical memorandum on the proposed boundaries of the removal action fulfills Task 3 of the work plan. This document provides rationale for the proposed removal action boundary in Section 3.0. The final cleanup boundary will be decided upon when the Office of Environmental Cleanup Director signs the Action Memorandum following EPA approval of the engineering evaluation/cost analysis (EE/CA).

2.0 Process for Boundary Delineation

PCBs were identified as the primary risk driver for the cleanup action at the T-117 shoreline (Windward 2003b; Windward et al. 2003a). Field sampling investigations were conducted to fill identified data gaps (Windward et al. 2003a). Data were collected to characterize the nature and extent of PCBs in the T-117 EAA, determine the removal action boundary needed to reduce the risks associated with PCBs in LDW sediment, and establish the general engineering characteristics of the shoreline sediment for constructability of potential removal actions. Full-suite Washington State Sediment Management Standards (SMS) source evaluation sampling was also conducted to determine the potential for sediment recontamination. The following types of samples were collected:

- Core and surface grab samples in the adjacent shoreline sediment
- Soil grab samples from catch basins on T-117 upland property
- Soil grab samples from the roadway near most upgradient catch basins
- Seep samples from the bank of the T-117 shoreline
- Soil borings along the top of the bank
- Soil from the southern drainage ditch
- Groundwater samples from monitoring wells located on the top of the bank and tidal monitoring

Section 2.4 of the EE/CA contains a summary of all data that have been collected (i.e., historical data and data collected as part of this investigation) and that are relevant for developing an appropriate boundary for the removal action. All physical and analytical data collected to date during this investigation can be found in the final data report (Windward et al. 2005). The final data report includes all the contents of the three draft data reports submitted earlier this year, the results of the roadway soil samples, and additional supplemental sediment samples. Additional samples for chemical analysis may be collected later, if necessary for the design of the removal action. Results from such additional analyses will be reported in a separate data report.

3.0 Justification of Boundary Determination

The removal action boundary shown in Figure 2-15 (see map folio) was drawn to delineate the area for removal of PCBs in sediment and bank soils so that risks in the LDW due to PCBs associated with T117 EAA are substantially reduced. Accordingly, the boundary of the removal area was determined by evaluating the distribution of PCBs in the T-117 shoreline bank and offshore sediments.

The proposed boundary defining the T-117 removal area was developed using a weight-of-evidence approach, including comparison of chemical concentrations to Washington State Sediment Management Standards (SMS) numerical criteria for sediment quality standards (SQS)and cleanup screening levels (CSL) (WAC 173-204). These values provide a foundation for identifying the aerial extent of sediments that may pose a risk to some ecological receptors, and are thus useful for identifying sediments that pose unacceptable risks. Sediments that are not identified as requiring removal using these values will continue to be evaluated for risks to both human health and other ecological receptors by the LDW RI/FS human health and ecological baseline risk assessment processes.

The T-117 data evaluation is based on 167 PCB concentrations measured in samples collected during EAA activities, plus historical data. The boundary is configured such that the area outside of the removal area to the navigation channel line and up to 300 feet north and south of the boundary has an average PCB concentration (8.4 mg/kg-OC) below the SMS PCB criteria (SQS for PCBs is 12 mg/kg-OC). Following the removal action, the average PCB surface sediment concentration within the removal area will also be below the PCB SQS, because most of the new surface will consist of new material. All sediments located outside of the removal area boundary will be included in the Phase 2 LDW risk assessment.

The proposed removal boundary is two-dimensional. The vertical extent of the proposed removal boundary will be determined later using the subsurface sediment data collected during this EAA investigation and any additional characterization data that may be collected during remedial design.

3.1 BOUNDARY DEFINITION

This section presents the specific rationale used in determining the location of the proposed removal action boundary. The boundary is shown on Figure 2-15 (see map folio).

- **General Approach**
  - Boundary is defined using PCBs results in a weight-of-evidence approach because the aerial distribution of elevated PCBs concentrations is greater than the distribution of other chemicals with elevated concentrations.
  - All surface sediment samples and upland soil samples from exposed (unpaved) soil areas adjacent to the river with concentrations above the PCB CSL are included in the removal action area.
  - All sediments located outside of the removal area boundary will be included in the LDW baseline ecological and human health risk assessments.
- **Uplands**
  - The general upland limit of the removal area boundary is shown in Figure 2-15 (see map folio) and will be adjusted inland as necessary based on the

results of the June 2005 supplemental upland subsurface soil sampling (Windward et al. 2005c). Soil removal adjacent to the 1999 PCB soil removal area will be limited by the location of the clean 1999 quarry-spall backfill, which corresponds to the present edge of pavement. The Port and the City will continue consultation with EPA and Ecology, during the design phase, regarding specific localized areas for additional high PCB soil removal. This removal may include soil beneath the existing asphalt cap where appropriate and necessary.

- PCBs above TSCA(50 mg/kg dw) criteria requiring disposal in a hazardous substance landfill will be removed.
- Catch basin 5 and surrounding soils will be removed and replaced with a structure better suited for retaining sediment and undergo periodic cleaning.
- The ditch along the southern property boundary of T-117 is included within the boundary. The delineation of the vertical extent of the ditch included in the boundary is presented in Figure 2-15 (see map folio).

- **Intertidal/In-water**
  - The historical and recent sediment sampling data shows a spatial trend of PCB concentrations that decrease from the bank out towards the navigation channel (Figure 2-15, see map folio), with all sediment samples with PCB concentrations above the PCB CSL (65 mg/kg-OC) found within 100 feet of the top of the bank.
  - The aquatic portion of the removal action boundary is based on the observed spatial trend of the PCB data, with the boundary generally paralleling the shoreline. PCB concentrations are higher near the shoreline and in the bank and gradually decrease moving away from the shoreline.
  - Over seventy-five percent of the PCB surface (0-10 cm) sediment concentrations between the outer boundary of the removal area and the navigation channel (19 of 25 samples) are less than the PCB SQS (12 mg/kg OC).
  - Of the six surface sediment samples that are located between the outer boundary of the removal area and the navigation channel that exceed the PCBs SQS, all are less than twice the PCB SQS (2 x 12 = 24 mg/kg OC) and well below the PCBs CSL (65 mg/kg OC).
  - The average PCBs surface sediment concentration for stations located between the outer boundary of the removal area and the navigation channel is 8.4 mg/kg OC, which is well below the PCBs SQS.
  - The boundary adjacent to the South Park Marina was defined such that sediments that will be dredged by the marina for a navigation project can be

disposed of at the Elliott Bay Open Water Disposal (PSDDA) site. The removal action boundary includes marina sediments that do not pass PSDDA guidelines for open water disposal of PCBs.

- The spatial distribution of elevated PCBs concentrations is such that the boundary at the north and south ends of the site can be drawn along the property lines, which greatly facilitates cleanup. In the intertidal/subtidal area, the boundary is shifted about 15 feet north of the property line at the north end and about 15 feet south at the south end to ensure that high PCB concentrations are removed. The northern and southern boundaries were placed to maximize inclusion of elevated PCBs in the removal area. The southern extent of PCB concentrations are shown on Figure A-1 (see map folio).

3.2 PRELIMINARY ANALYSIS OF RECONTAMINATION

Potential pathways for sediment contamination from upland sources were initially identified for the T-117 project area in the Summary of Existing Information and Data Needs Analysis (Windward et al. 2003a) and included:

- Stormwater drain sediment (catch basins and drainage ditch)
- Groundwater discharges, including shoreline seeps
- Direct erosion of contaminated shoreline bank materials.

Potential solids loading to the sediment from stormwater discharge and erosion of contaminated shoreline and ditch materials appears to be the most significant potential upland source. Contaminated solids in the stormwater drainage system appear to be historical and have been mostly removed. Although this action has significantly reduced storm drain solids as a potential source of future sediment recontamination, this will need to be verified by additional sampling of re-accumulated solids. Any solids remaining in the interconnecting drain and outfall lines will also need to be removed during the removal action. These lines are not shown inside the boundary on Figure 2-15 (see map folio), but they will be cleaned as needed during the removal.

Erodible materials in the shoreline bank and ditch represent the most significant ongoing potential source and are therefore included in the proposed removal action boundary. Following the early action they will no longer pose a risk of re-contamination to the sediment since they will be either removed or physically isolated from the LDW. Groundwater and shoreline seeps do not appear to be transport pathways for contaminants of concern in the sediment. Each pathway is discussed further in section 2.7 of the EE/CA.

4.0 References

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APPENDIX B. TOXICOLOGICAL PROFILE FOR POLYCHLORINATED BIPHENYLS (PCBS)

Appendix B. Toxicological Profile for Polychlorinated Biphenyls (PCBs)

Although the production and use of PCBs were banned in this country in 1979, this chemical group is extremely persistent in the environment and bioaccumulates through the food chain (EPA 2000). There is evidence that some dioxin-like PCB congeners, which are assumed to be the most toxic, preferentially accumulate in organisms higher on the food chain, including humans. As a result, the composition of PCB mixtures in fish tissue may differ significantly from the environmental PCB source. Often the mixtures of interest are not those that have been used in studies of laboratory animals to determine toxicity (EPA 2000).

Pharmacokinetics

PCBs are absorbed through the gastrointestinal tract and distributed throughout the body, although the highest accumulation is typically in lipid-rich tissues. Human milk may contain relatively elevated PCB concentrations due to its high fat content (ATSDR 2000).

The retention of PCBs in fatty tissues is linked to the degree of chlorination and also to the position of the chlorine atoms in the biphenyl ring. In general, more chlorinated congeners persist for longer periods of time. In occupationally exposed individuals, less chlorinated congeners had half-lives between 1 and 6 years, while more chlorinated congeners had half-lives ranging from 8 to 24 years (ATSDR 2000). In subjects who consumed PCB-contaminated rice in Taiwan, the half-lives of several PCBs ranged from 3 to 24 months (EPA 2000).

Acute toxicity

Studies in animals have shown that exposure to very high doses of PCBs can cause death. However, doses of such magnitude are unlikely in environmental exposures and current industrial settings. There have been no reports of deaths in humans after exposure to PCBs even where exposures were much higher than those typically identified with environmental exposures (ATSDR 2000).

Chronic toxicity

Numerous effects have been documented in animal studies including hepatic, GI, hematological, dermal, body weight, endocrine, immunological, neurological, reproductive, developmental, and liver cancer (ATSDR 2000). Evidence of chronic effects in humans is not nearly as definitive. Several studies in humans have suggested that PCB exposure, particularly via in utero exposure through maternal fish consumption, may cause adverse effects in children and in developing fetuses (ATSDR 2000). Neurobehavioral effects in such children have been documented by Fein et al. (1984), Jacobson and Jacobson (1996, 1997), and Schantz (1996). Over intermediate durations (i.e., less than 10% of an organism's lifetime), learning problems have been

noted in monkeys fed PCB mixtures similar in composition to human breast milk (ATSDR 2000).

EPA has derived an **RfD of 2×10^{-5} mg/kg-day** for Aroclor 1254. The RfD was based on a LOAEL of 0.005 mg/kg-day for ocular and immunological effects in monkeys. Uncertainty factors of 10 for sensitive individuals, 3 for extrapolation from monkeys to humans, 3 for extrapolation from a subchronic exposure to a chronic RfD, and 3 for use of a minimal LOAEL were applied by EPA, resulting in a total uncertainty factor of 300. EPA's overall confidence in the RfD is rated as medium, based on medium confidence levels for both the primary study and the supporting database.

Carcinogenicity

PCBs are classified by EPA as Class B2, probable human carcinogens. This designation is based on studies that have found liver tumors in rats exposed to Aroclors 1260, 1254, 1253, and 1016. Human epidemiological studies of PCBs have not yielded conclusive results (Silberhorn et al. 1990).

EPA has developed a range of slope factors for PCBs (EPA 1996). Using information on environmental processes, they have provided guidance for choosing an appropriate slope factor based on the class of the mixture and the exposure pathway. Because bioaccumulated PCBs appear to be more toxic and more persistent in the body than commercial PCBs, the upper bound slope factor associated with high risk and persistence (**2.0 per mg/kg-d**) was used in this HHRA.

When assessing PCB mixtures, it is important to recognize that both dioxin-like and non-dioxin-like modes of action contribute to overall PCB toxicity. It is possible that concentrations of dioxin-like congeners are increased in an environmental mixture. When congener concentrations are available, the mixture-based approach based on Aroclor analyses can be supplemented by analysis of dioxin TEQs to evaluate dioxin-like toxicity. In that analysis, the dioxin slope factor (150,000 kg-day/mg) is used. In some cases, the magnitude of the dioxin slope factor results in PCB dioxin-like congeners contributing the majority of the risk.

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APPENDIX D. DATA MANAGEMENT

Appendix D. Data Management

LABORATORY REPLICATES AND FIELD DUPLICATES

Chemical concentrations obtained from the analysis of laboratory replicates (two or more analyses done on the same sample). Results for replicates were averaged according to the following rules.

Averaging rules were dependent on whether the result was a "detect" or "non-detect." If all concentrations were detects for a given parameter, the values were simply averaged arithmetically. If all concentrations were undetected for a given parameter, the minimum detection limit was reported as the "average." If the concentrations are a mixture of detects and non-detects, only the detected concentrations are averaged and the result is considered a detected concentration. The following table illustrates the three cases with example data.

Table D-1. Example calculations

CHEMICAL	CONCENTRATION 1	CONCENTRATION 2	AVERAGE CONCENTRATION
Lead	50	40	45
Hexachlorobenzene	10 U	20 U	10 U
Mercury	0.50	0.60 U	0.50

U represents a non-detect concentration

SIGNIFICANT FIGURES AND ROUNDING

The laboratory typically reports results with 2 or 3 significant figures depending on the instrument. Examples:

Table D-2. Examples of different numbers of significant figures

2 SIGNIFICANT FIGURES	3 SIGNIFICANT FIGURES
19	19.1
120	122
3,600	3,550

When a calculation involves addition, such as totaling PCBs or PAHs, the calculation can only be as precise as the least precise number that went into the calculation. Example (assuming 2 significant figures):

> 210+19=229, but this would be reported as 230 because the trailing zero in the number 210 is not significant.

When a calculation involves multiplication or division, such as when carbon normalizing, all significant figures are carried through the calculation and then the

total result is rounded at the end of the calculation to reflect the value used in the calculation with the fewest significant figures. Example:

> 59.9 x 1.2 = 71.88, but this would be reported as 72 because there are only 2 significant figures in the number 1.2

When rounding, if the number following the last significant figure is less than 5, the digit is left unchanged. If the number following the last significant figure is equal to or greater than 5, the digit is increased by 1.

CALCULATING TOTALS

Concentrations for several analyte sums were calculated as follows:

- **Total PCBs** were calculated using only detected values for 7 Aroclor mixtures[1] in accordance with Ecology's Sediment Management Standards (SMS). For individual samples in which none of the 7 Aroclor mixtures were detected, total PCBs were given a value equal to the highest detection limit of the seven Aroclors and assigned a "U" qualifier indicating the lack of detected concentrations.
- **Total LPAHs, HPAHs, and benzofluoranthenes** were also calculated in accordance with SMS. Total LPAHs are the sum of detected concentrations for naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene. Total HPAHs are the sum of detected concentrations for fluoranthene, pyrene, benzo(a)anthracene, chrysene, total benzofluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene. Total benzofluoranthenes are the sum of the b (i.e., benzo(b)fluoranthene) and k isomers. For samples in which all individual compounds within any of the three groups described above were undetected, the single highest detection limit for that sample represents the sum.

ORGANIC CARBON NORMALIZATION

Organic carbon normalization was conducted for many organic compounds for the purposes of comparing to SMS. Because of the significant figure and rounding algorithms described above, the organic carbon normalized totals may not be exactly equal to the sum of the organic carbon normalized individual compounds. For example, the organic carbon normalized total LPAH concentration was calculated using the dry weight total LPAH concentration and the organic carbon percentage, not by summing the organic carbon normalized concentrations for the individual LPAH compounds.

On figures with sample locations with field duplicates, each value was organic carbon normalized and then averaged.

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[1] Aroclors 1016, 1221, 1232, 1242, 1248, 1254, 1260